BENEFICIAL USE AND TREATMENT OF CONTAMINATED CLAREMONT CHANNEL SEDIMENT USING PROPAT®

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ABSTRACT

Hugo Neu Schnitzer East will dredge approximately 1.2 million cubic yards to remove contaminated sediments and deepen the Claremont Channel. Chemical analyses, elutriate tests, and bioassays conducted on the sediments have shown elevated levels of metals, PCBs, and other constituents of concern. Disposal of large volumes of sediments unsuitable for open-water disposal is increasingly expensive in the New York/New Jersey region since the "Mud Dump" ocean disposal site was closed to all but the cleanest material in 1997. As a result, alternatives such as beneficial use of dredged sediments are being promoted by the states of New York and New Jersey, federal regulators, and the environmental community. One of the proposed alternatives for the Claremont Channel is to amend contaminated dredged sediments with PROPAT®, a trademarked auto-shredder byproduct, to form a manufactured soil-like material for use as structural fill. The amended material would be used to cap and grade a portion of a nearby former industrial site, enabling construction of a golf course. PROPAT®, previously approved for landfill cover in several states and developed by Hugo Neu Schnitzer East, is the chemically stabilized nonmetallic part of shredded cars (i.e., foam from the seats, glass, etc.). This is the first use of PROPAT® as an amending agent for dredged sediments, and is based in part on experiments conducted with waste carpet fibers that produced promising results.

This paper discusses the applicability of amending contaminated dredged material with PROPAT® as a beneficial use of dredged sediments. The chemical and physical composition of the manufactured fill material is addressed since the level of contamination and structural/geotechnical properties of the material have an affect on the application of the material. This paper presents the methodology developed to determine the dredged sediment processing train, mixing ratios of the dredged sediments and PROPAT®, and the handling process. Descriptions and interim results of the bench, pilot, and full scale demonstration projects using PROPAT® with dredged material are discussed.

INTRODUCTION

The Hugo Neu Schnitzer East Company (HNSE), in conjunction with the New Jersey Commerce and Economic Growth Commission, Maritime Resources, is considering dredging the state-owned Claremont Channel to provide access for deeper-draft vessels. According to the Corps of Engineers (Corps), up to 2 million cubic yards of sediments would require removal (Summary Report, June 1996) to provide the desired navigational depth of 34 feet below mean low water. Funding limitations have forced a revised channel design resulting in a lower removal volume estimated at 1.25 million cubic yards. Claremont Channel sediment samples have shown that the dredged material is unsuitable for ocean disposal and will require some type of additional management to ensure proper disposal.

The New Jersey Department of Commerce has supported the concept of combining the channel deepening and nearby site restoration projects by using the dredged sediments as fill material after some conditioning and perhaps some stabilization to minimize the potential for leaching of contaminants of concern. PROPAT® is a trademarked chemically stabilized product of HNSE which is recycled from processing the non-metallic interior materials of shredded automobiles. PROPAT® has been approved as interim daily landfill cover in several states and was approved in New Jersey for "cushion" material above a liner at the Pennsauken, New Jersey landfill.

PROPAT® may serve as an effective dehydrating agent, improving the handling characteristics of the dredged material which is received at 60 to 70 percent water and improving the strength of the material through the addition of fiber content. However, testing is necessary to demonstrate its suitability as fill material to the NJDEP, as a first step in obtaining an Acceptable Use Determination (AUD) for the reuse of amended dredged material. More specifically, the testing must directly address dredged material contaminant mobility, which is a key issue in NJDEP's evaluation under the AUD. In addition, the geotechnical properties of the material must be tested to support use by designers.

BENEFICIAL USE ALTERNATIVES FOR CLAREMONT CHANNEL AMENDED DREDGED MATERIAL

Several beneficial use alternatives for amended dredged material from the Claremont Channel were identified by HNSE. These beneficial reuse options include:

Mine Reclamation. Amended dredged material could be used as fill material for reclamation of the Bark Camp Mine facility in Pennsylvania, with the material being used to reduce problems associated with acidic leachate in the abandoned open strip mine. The treated dredged material would be tested to meet Pennsylvania requirements for mine reclamation.

Structural Fill. Treated dredged material could be used as grading material for the Port Liberte golf course, located north of the Claremont Channel in Jersey City, NJ.

Cap Material. Two former industrial properties could be capped using the amended dredged material.

For each reuse alternative, physical and chemical testing of the materials will be required. In addition to the federal agencies, several states and the regional Corps Districts would be involved in approval of the testing required for reuse of the dredged material. The Pennsylvania Department of Environmental Protection (PADEP) would issue an Amended Beneficial Use Order (BUO) for authorization of the placement of the treated dredged materials in the mining facility.

PERFORMANCE GOALS

The objective of this work is to determine what type of conditioning would be needed to transform the sediments of the Claremont Channel into a usable fill material which can be handled with standard earth-moving equipment and is protective of the environment. The amended sediment mixture will have to meet geotechnical and environmental requirements to become a suitable fill material.

Several years ago, researchers at Georgia Tech University conducted laboratory strength and deformation tests on mixtures of waste carpet fibers with silty, clayey sand. The purpose of the tests were to evaluate the strength improvement of the material for structural fill. The results were promising. Since PROPAT® has a higher fiber content than floor carpeting and other non metallic content of automobile interiors, it was hypothesized that the free water in the received dredged material might be reduced and provide greater strength in the final mix. Further, it might reduce the need for addition of pozzolanic materials such as fly ash, lime kiln dust, cement kiln dust lime or cement.

The following geotechnical criteria were established for the project:

- Workable and manageable by standard earth-moving equipment;
- Sufficient strength and elasticity to be suitable as backfill; and
- Sufficient geotechnical and hydraulic conductivity properties to be usable as fill material.

Material will need to meet applicable environmental standards including:

- The appropriate soil quality standards;
- Groundwater quality standards;
- Surface water quality standards; and
- Fugitive dust emissions standards.

Soil, groundwater, and surface water quality standards are listed in the Management and Regulation of Dredging Activities and Dredged Material October 1997 Technical Manual. Of primary concern is the demonstration that leaching from the PROPAT® or the sediment itself will not violate applicable standards.

SEDIMENT QUALITY

Table 1 summarizes data on Claremont Channel sediments from recently collected samples. These data have been compared to appropriate sediment screening criteria, and the few parameters where those criteria are exceeded can be seen on the table.

DREDGED MATERIAL STABILIZATION WITH PROPAT®

Several phases of the stabilization process progressing from laboratory tests to a full-scale site demonstration will be performed and evaluated. To date, the initial geotechnical testing has been completed, demonstrating that the clayey sediment can be turned into a usable fill material which can be handled with standard earth-moving equipment. Testing has been performed on a representative Claremont Channel sediment sample and a PROPAT® sample (as provided by HSNE) to determine their geotechnical characteristics alone. The sediment and PROPAT® were then combined in various proportions, with and without additional kiln dust, to create suitable mixes. Results are presented below.

Initial Testing of Sediment and PROPAT®

Two 5-gallon buckets each of sediment and PROPAT® were tested as follows:

- Determining the as-delivered moisture content (ASTM D 2216 Test Procedures) and optimum moisture content and corresponding dry density of the sediment and PROPAT® with modified

Table 1 - Statistical Summary of Analytical Results for Claremont Channel Sediment Samples

Analyte	Range	Average	Sediment Screening Level
Conventionals in %			
Total Organic Carbon	.17 to 3.52	2.39	-
Grain Size in %			
Gravel	0 to 22	3	-
Sand	6 to 72	27	-
Silt	4 to 54	39	-
Clay	4 to 46	31	-
Metals in mg/kg			
Arsenic	9.08 to 17.7	12.4	20
Cadmium	2.1 to 8.07	4.4	1
Chromium	84.5 to 219	137	
Copper	76.2 to 195	120	600
Lead	96 to 261	158	400
Mercury	1.41 to 4.87	2.7	14
Nickel	20.2 to 37.2	28.4	250
Silver	2.83 to 11	6.04	110
Zinc	148 to 308	206	1500
PAHs in mg/kg			
Acenaphthene	.0874 to .306	0.2	3400
Acenaphthylene	.068 to .199	0.127	
Anthracene	.285 to .963	0.57	10000
Benzo(a)anthracene	.471 to 1.24	0.815	0.9
Benzo(a)pyrene	.53 to 1.47	0.95	0.66
Benzo(b)fluoranthene	.678 to 1.88	1.18	0.9
Benzo(g,h,i)perylene	.361 to 1.06	0.655	
Benzo(k)fluoranthene	.22 to .631	0.393	0.9
Chrysene	.47 to 1.29	0.81	9
Dibenz(a,h)anthracene	.095 to .284	0.17	0.66
Fluoranthene	.827 to 2.16	1.43	2300
Fluorene	.123 to .397	0.22	2300
Indeno(1,2,3-cd)pyrene	.349 to .99	0.63	0.9
Naphthalene	.249 to 1.28	0.75	230
Phenanthrene	.466 to 1.5	0.894	
Pyrene	.861 to 2.35	1.55	1700
1,4-Dichlorobenzene	90.4 to 485	249.5	570
Pesticide/PCBs in µg/kg			
2,4'-DDD	6.48 to 30.8	15.54	
2,4'-DDE	.61 U to 1 U	0.39	
2,4'-DDT	.21 U to .35 U	0.14	
4,4'-DDD	16.6 to 86.6	42.63	3000
4,4'-DDE	25.9 to 124	62.50	2000
4,4'-DDT	9.1 to 33.6	19.67	2000
Aldrin	7.73 to 23.9	14.94	40
Dieldrin	1.93 to 12.2	6.24	42
Endosulfan I	.28 U to .47 U	0.18	
Endosulfan II	.28 U to .47 U	0.18	
Endosulfan sulfate	.23 to 2.15	1.14	
Heptachlor	.06 U to .1 U	0.04	150
Heptachlor epoxide	.28 U to .46 U	0.18	
alpha-Chlorodane	3.49 to 12.2	6.90	
trans-Nonachlor	1.71 to 6.65	3.78	
Total PCBs	374 to 1510	848	490

Proctor tests (ASTM D 1557 Test Procedures);

- Determining the plasticity characteristics of the sediment through Atterberg limits; and

- Performing a grain size analysis (mechanical method with hydrometer, ASTM D 422 Test Procedure) on both sediment and PROPAT® samples.

Results of this testing are presented in Table 2. It was observed that both materials had a natural moisture content that was wet of optimum, indicating that field drying or addition of another drying compound would likely be required to attain adequate compressive strength. The "as-delivered" sediment moisture content was 143 to 166 percent. For geotechnical purposes, moisture content is defined as the weight of water divided by the weight of dry solids (as opposed to the weight of water divided by the total weight of the sample).

It is important to note that ASTM procedures require screening the samples through a ¾-inch sieve before determining the optimum moisture content and maximum dry density. This did not affect the sediment sample but eliminated from 4 to 15 percent by weight of the PROPAT®. The presence of the oversize material during full-scale work is expected to reduce the moisture adsorption capacity of the PROPAT® compared to the minus ¾-inch material. However, it would also likely increase the strength of the mixture. It may not affect permeability significantly since permeability is controlled by the fine material as long as it is present in sufficient quantity to fill the voids between the plus ¾-inch material. The Atterberg limit determination requires screening through a ¼-inch sieve before testing.

The variability in the plus ¾-inch fraction in PROPAT® is likely due to the screening technique as much as product variability. The fibers in PROPAT® prevent many particles smaller than ¾-inch to pass unless they are manually pushed through the product fibers and the screen. With the first batch, PROPAT® was agitated by hand inside the sieve but individual particles were not pushed through the screen. This is more representative of full-scale, industrial screening. With the second batch, nearly every particle was pushed through the sieve opening to maximize the PROPAT® fraction usable in the test.

Phase I - Bench-Scale Mixture Preparation and Testing

Mix Design

Ten additional 5-gallon buckets each of PROPAT® and sediment were used for the mix design. The sediment samples received appeared to be clayey silt. Two iterations were performed to obtain mixtures with potential as fill or capping material. Based on the results obtained during the initial testing, the following three mixtures were prepared:

- 1:1 PROPAT® : sediment ratio (wet weight);
- 2:1 PROPAT® : sediment ratio; and
- 3:1 PROPAT®: sediment ratio.

The 1:1 mixture appeared to be too wet and muddy to be manageable. The 2:1 mixture appeared still wet of optimum but seemed to be a promising candidate for further testing. There was little improvement in the 3:1 mixture compared to the 2:1 mixture.

Table 2 - PROPAT® and Claremont Channel Sediment Characteristics

Material	Natural Moisture Content in percent (dry weight)		Fraction above 3/4 inch in percent (dry weight) (1)		Fraction passing No. 200 Sieve in percent (dry weight)	Maximum Dry Density in pcf	Optimum Moisture Conten in percent	Percent		
	First Batch	Second Batch	First Batch	Second Batch	First batch			Liquid Limit	Plastic Limit	Plasticity Index
PROPAT®	24	22	14.9	4.3	7.3	83	13.7	NT	NT	NT
Sediment	166	143	0	0	97	83	28.3	130	48	82
Kiln Dust	NT	0.2	NT	NT	NT	NT	NT	NT	NT	NT

(1) The difference between the two PROPAT® measurements reflects variability in the product but also the effort spent in the sieving process.
The fibers in PROPAT® prevent many particles less than 3/4 inch to pass unless they are manually pushed through the product fibers and the screen.
With the first batch, PROPAT® was agitated by hand but individual particles were not pushed through the screen. This is representative of industrial screening.
With the second batch, nearly every particle was pushed through the sieve opening to maximize the PROPAT® fraction usable in the test.

NT = Not tested.

Therefore, the 3:1 mixture was eliminated from further consideration. Since the PROPAT® production rate is expected to be insufficient to allow a 2:1 mixture for the combined volumes of fill and low permeability material needed, it was decided to add kiln dust to the 1:1 mixture to see if that would improve its characteristics. The following three additional mixtures were prepared:

- 1:1 PROPAT® : sediment ratio with 5% kiln dust based on mixture wet weight;
- 1:1 PROPAT® : sediment ratio with 10% kiln dust based on mixture wet weight; and
- 1:1 PROPAT® : sediment ratio with 20% kiln dust based on mixture wet weight.

After allowing these mixtures to cure, the mixtures with 10 and 20 percent kiln dust were selected for further testing. Five percent kiln dust did not improve the characteristics of the mixture sufficiently. The 1:1 PROPAT® sediment mixtures with 10 and 20 percent kiln dust, along with the 2:1 PROPAT® sediment mixture (without kiln dust), were tested as described below.

Geotechnical Testing

The following tests were performed on the mixtures of sediment, PROPAT® and kiln dust:

- Optimum moisture content of the mixtures with standard or modified Proctor tests;
- Atterberg limits of each mixture; and
- Unconsolidated undrained compression tests (ASTM D 2850 Test Procedure).

Results are presented in Table 3. The following observations and conclusions were made:

- Mixing of sediment with PROPAT® substantially reduced the moisture content of the sediment. The mixed moisture content was reduced to within about 30 percent of the optimum for compaction. Similar results were observed for the addition of kiln dust, wherein, the reduction in as-delivered moisture was not as great, but the optimum moisture for compaction was also increased.

- Unconfirmed compressive strengths are close to, or exceed, the 30 psi requirements set forth for the Liberty National Development Project.

- The ratio of PROPAT® and kiln dust to sediment should be significantly better (i.e., less required PROPAT® and less required kiln dust) if sandier and/or drier sediment is used.

- It is likely that the admixed material can be successfully used as general site grading fill over the capping layer. In this case, the primary requirement for the material would likely focus on the ability to simply place the material and to operate large earth-moving equipment on top of it.

The results of the Phase I bench-scale testing are promising even though very clayey sediments were used. Phase II testing will focus on contaminant mobility testing and optimization of the mix design.

Phase II - Bench-Scale Testing of Optimal Mixtures

The objective of the second round of bench scale testing is to establish the strength,

Table 3 - Claremont Channel Sediment/PROPAT® Mixture Testing Results

Mixture Design		Mixture Moisture Content in percent	Maximum Dry Density in pcf	Optimum Moisture Content in percent	Compressive Strength in psf	Moisture Content of Strength Test Sample in percent	Percent		
PROPAT® to Sediment Ratio (wet weight)	Percent Kiln Dust by Wet Weight of Mixture						Liquid Limit	Plastic Limit	Plasticity Index
2:1	0	44.4	83	12.1	5290	24.6	53	38	15
1:1	10	54.4	81	19.8	3465	34.7	62	44	0
1:1	20	44.4	90	25.5	5591	34.9	57	41	16

Note: Moisture content values are based on dry weight.

permeability, and leachability of the best mixtures of dredged material and PROPAT® determined in Phase I. Further, methods of handling the material and constructing the cap would be tested in preparation of the pilot scale test.

Using the apparent optimum mixtures developed above, PROPAT® amended dredged material would be compacted by hand in a plastic cylinder or box frame using layers or lifts approximating the thickness and density of field applications. The actual thickness and number of lifts will depend upon the handling characteristics. It is anticipated that the cap would be formed over a column of clean sand in the cylinder facilitating subsequent testing for permeability and leaching.

After curing, the material samples would be tested for:

- tri-axial shear strength as a measure of resistance to tearing and cracking;
- permeability as a measure of ability to resist throughput of surface water percolation;
- leachability of contaminants in the amended sediments using toxicity characteristic leaching procedure (TCLP) tests; and
- bulk chemistry including VOCs, SVOCs (including PAHs), metals, PCBs, dioxins, and TOC analyses, to allow comparison with the leachate chemistry results.

Bench-scale testing of the optimal mixtures will begin in Spring 1999 following sediment collection from the Claremont Channel.

Phase III - Pilot Scale Dredged Material Processing and Addition of PROPAT®

It is anticipated that in order to obtain an AUD from the NJDEP and encourage the reuse of the amended dredged material by end users, the field practicality and cost effectiveness must be demonstrated on a scale that approaches actual field conditions. The first step will be to perfect the mixing methods to assure a consistent mixture which cures to meet the anticipated permit requirements. Although this will depend upon the actual results of the bench tests, three potential options may be anticipated as follows:

- Mechanical mixing in a cell on a small barge;
- Mixing in a pug mill on land; and
- Mixing using mobile equipment at the test cell.

It is proposed that a batch pilot scale of approximately 50 yd^3 would be adequate for a demonstration.

Construction of Test Capping / Liner Cell

A parcel of 1/20 acre, adjacent to the HNSE facility, would be established to demonstrate the construction of the amended material into a suitable cap. The material would be excavated from the barge or mixing cell or dumped from the pug mill and transported to the adjacent cell. Standard construction equipment would disk, roll, and compact the material. After curing, plug samples would test the consistency of strength, permeability, and leachability.

Full Scale Demonstration

A separate cell at the proposed Port Liberte' golf course would be created for a full scale demonstration. The cell would be large enough to accommodate 100,000 to 150,000 yd^3 of amended dredged material as bulk fill for grading material on the golf course site. Assuming an average depth of 10 feet of amended fill, roughly 10 acres of the Port Liberte' parcel would receive PROPAT® amended dredged material. Construction methods for the full scale demonstration would be determined during pilot tests, but standard earth-moving and grading equipment would most likely be used.

CONCLUSIONS

Hart Crowser, working with Hugo Neu Schnitzer East, is conducting experiments to determine the applicability of amending contaminated dredged material with PROPAT® to develop a beneficial use for dredged material from the Claremont Channel. This is the first use of PROPAT®, the chemically stabilized nonmetallic part of shredded cars (i.e., foam from the seats, glass, etc.), as an amending agent for dredged sediments. Current geotechnical testing results of several mixture ratios indicates the clayey dredged sediment can be formed into a usable fill material which can be handled with standard earth-moving equipment. Based on additional bench-scale strength, permeability, and leachability tests, to be performed this spring, the treated dredged material process will be applied in a pilot and full scale demonstration. During these demonstration projects, the amended dredged material would be use for structural fill and capping material.

This paper presented the methodology developed to determine the dredged sediment processing train, mixing ratios of the dredged sediments and PROPAT®, and the handling process. Descriptions and interim results of the bench, pilot, and full scale demonstration projects using PROPAT® with dredged material were discussed.

201-533-4300
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